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Understanding radar phenomenology of relocatable targets

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Remember Swynnerton (1/3)



GECKO_SA8

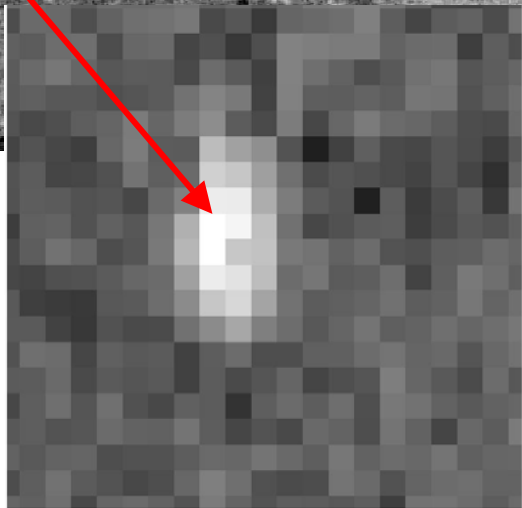
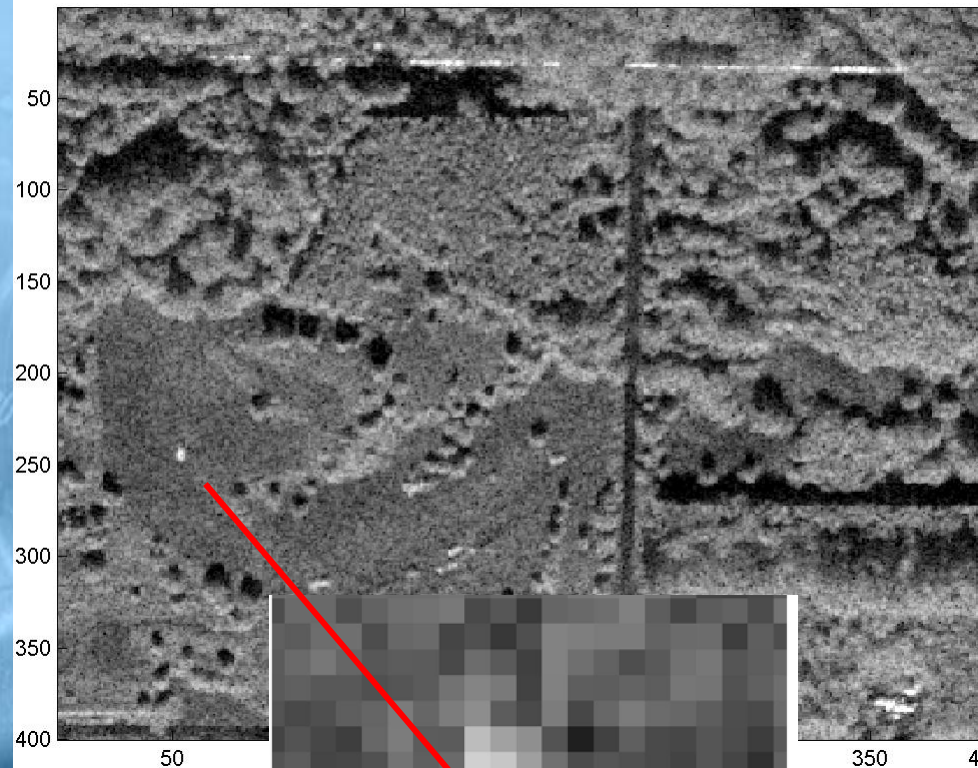


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Remember Swynnerton(2/3)

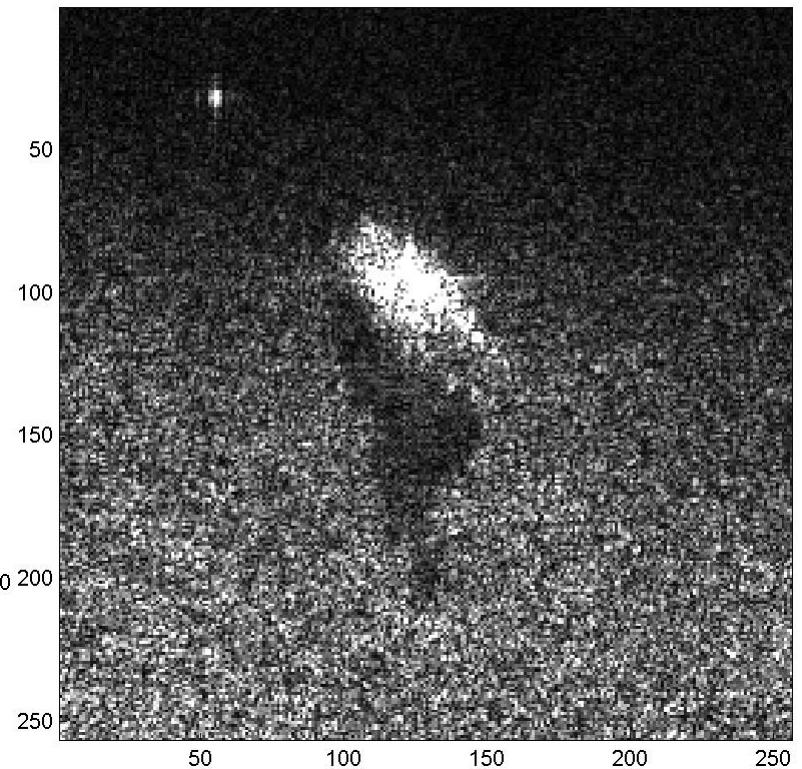
GECKO - SA8

Swynnerton - 1996 - Bande X - 1m resolution



Detection & Location

Swynnerton - Bande Ka - Between HR and THR



Detection - *Recognition ? - Identification ?* & Location

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Remember Swynnerton (3/3)



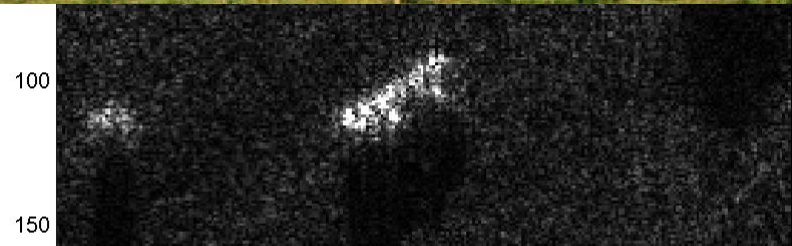
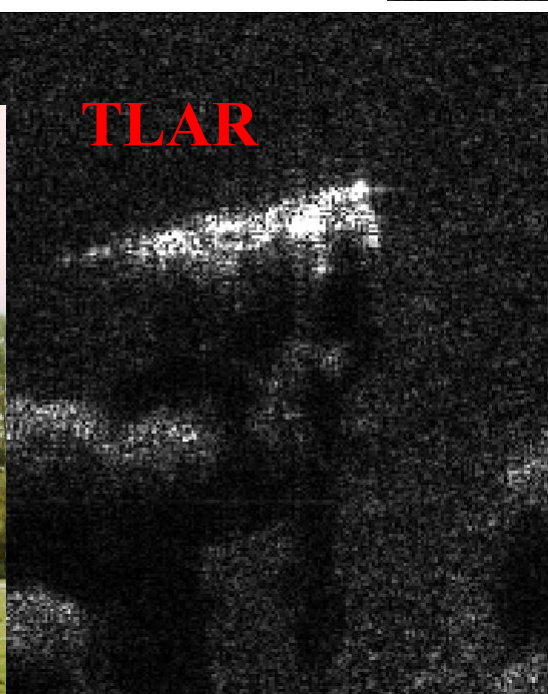
ASTROSS



MTLB



TLAR



**Ka waveform
between HR & THR**

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SAR Context

RAMSES Radar

Radar	P	L	S	X	Ku	Ka	W
Frequency (GHz)	0.43	1.3	3.2	9.5	14.3	35	95
Bandwidth (MHz)	75	200	300	1200	1200	1200	500

Better resolution for a higher quality SAR imager

But
What is the opinion of photo-interpreters ?

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What is a SAR image ?

- a 2D representation for a 3D vehicle,
- a compressed image,
- a bright area with more or less accurate contour, dominant scatterers
- a shadow or not,
- a geometric shape with different dynamic levels,
- the absence or the presence of such or such element (**versus resolution**)

& what is

Recognition : How do we recognise a target ?

- height, length and width,
- shape, particular elements (wheels and their number, antenna,...)
- material,
- environment,

➤ **Identification** : Which features identify a target ?

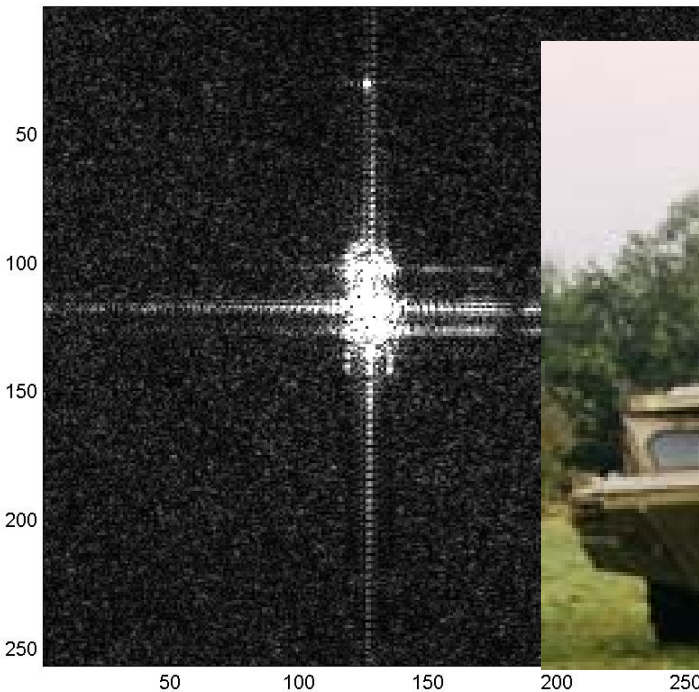
- position of elements between them

- shape of particular elements (square, round, ) **ONERA**

Strong impact of the target geometry

Phenomenological analysis

GECKO - First aspect angle



GECKO - Second aspect angle



SAR image is not an optical image but information about the target are on a SAR image



phenomenological analysis

Extract information from a SAR target image by

- describing physically the observed phenomena
- explaining the behaviour of the target versus configurations

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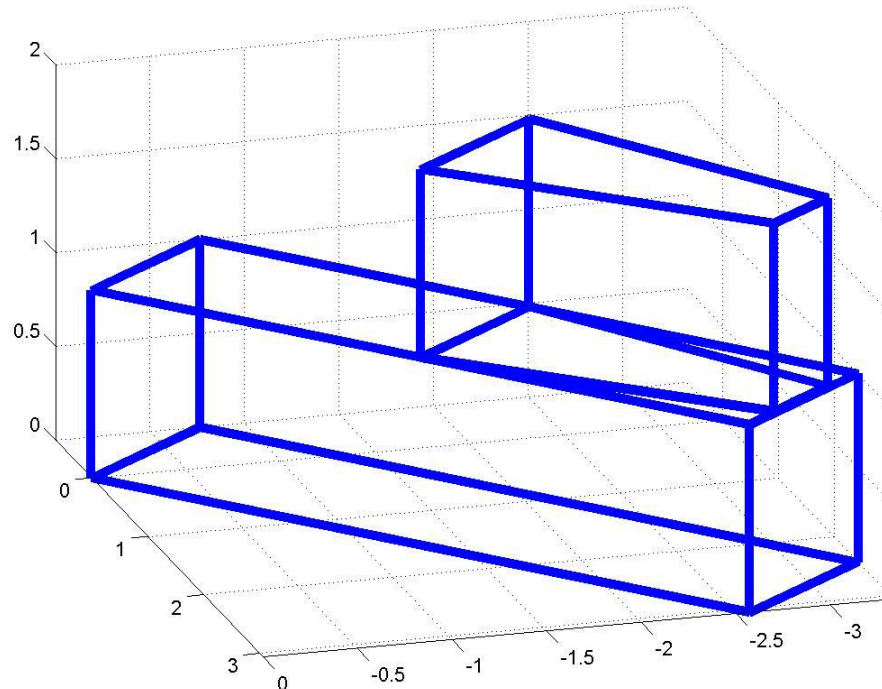
Methodology : Geometrical and physical approach

- **simulate** a target by selecting the most relevant features of a target (wheels, cabin,...)
- **calculate** the associated SAR image in the slant or ground range domain

Parameters :

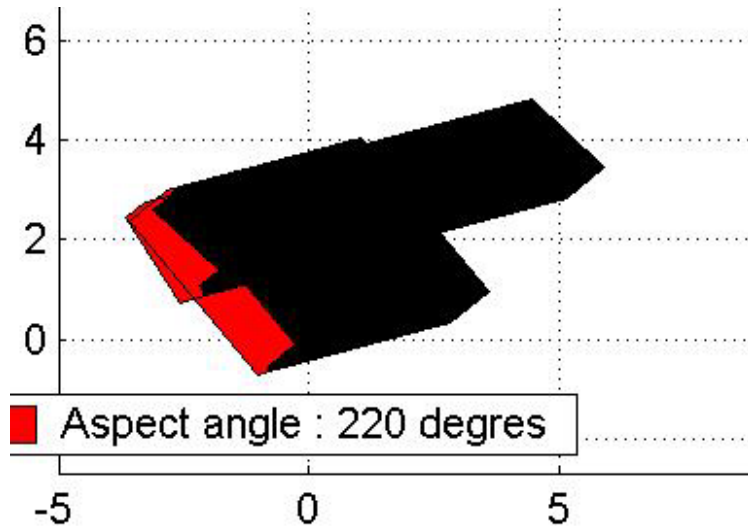
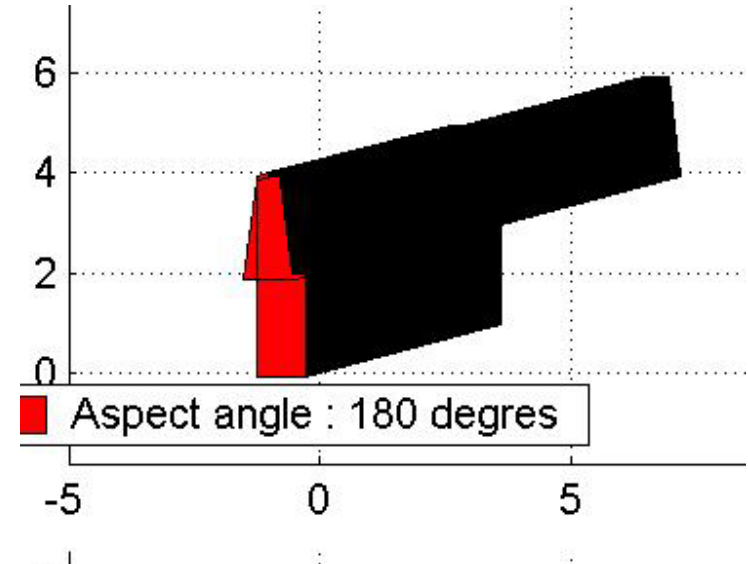
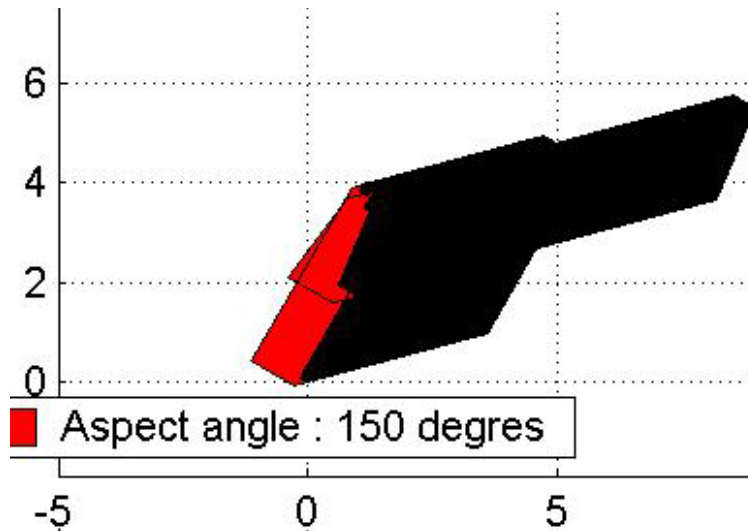
- **Operational conditions** : depression angle, radar band
- **Target characteristics** : type, aspect angle,
- **Environment** : grass, road, sea,...

A simple example



Radar image versus aspect angle

Depression angle : 15°



How to find an invariant ?

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Shadow Impact of the environment

Interests of shadow

- ☺ to estimate the height of the highest element of the target
- ☺ to estimate length or width of the target
- ☺ to have an idea of the shape of the target (wings of plane)
- ☺ to see element smaller than the resolution (gun of tank)

When do we have a shadow ?

Depends on

- the surface background - “*smooth to rough*”
- the radar band - “*X to Ka*”

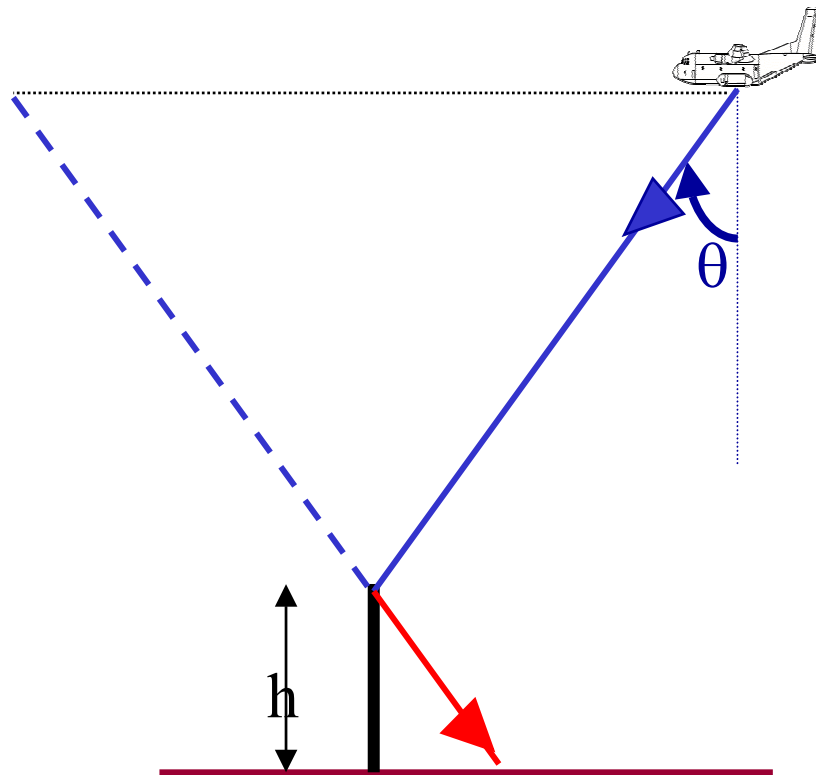
Without a shadow, a part of the information is absent but ...

Smooth surface and multi-path

Specular on a structure

optical geometry : plane mirror = structure

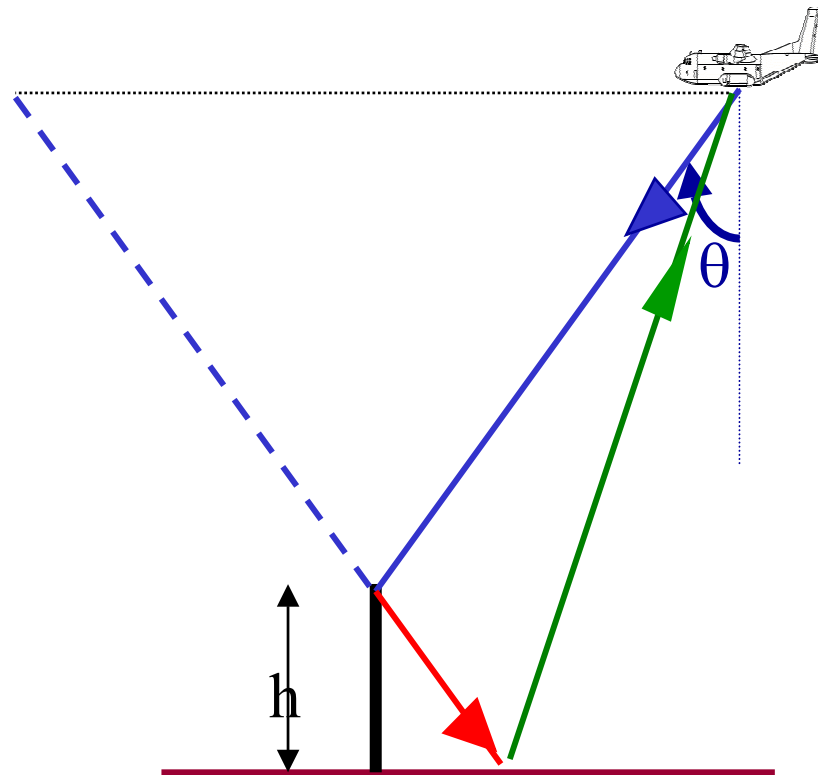
-  Incident Ray
-  Structure reflected ray






Smooth surface and multi-path

Specular on a structure

optical geometry : plane mirror = structure

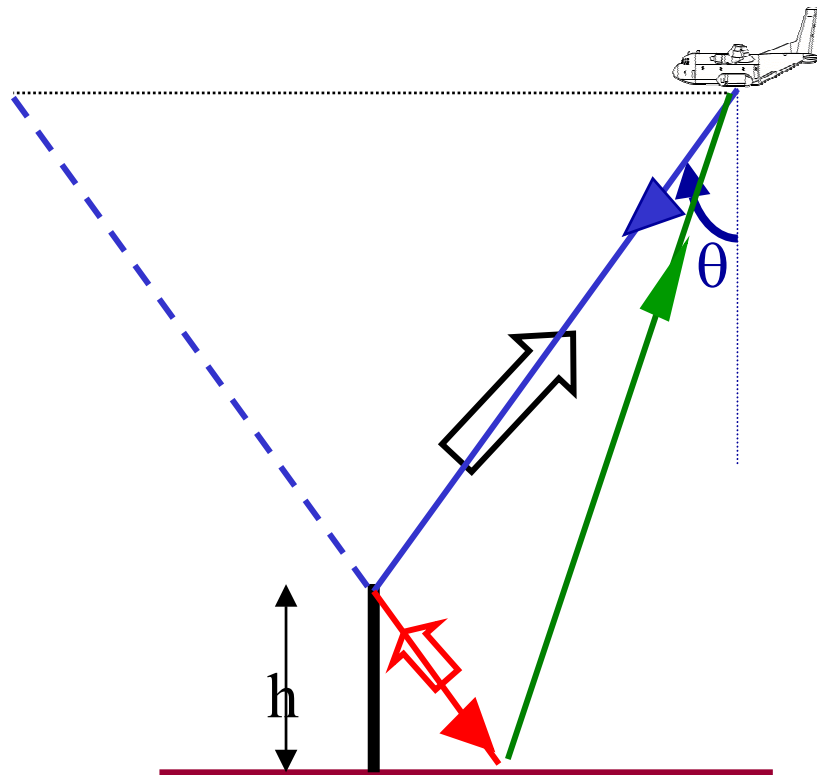


-  Incident Ray
-  Structure reflected ray
-  Surface reflected ray

Smooth surface and multi-path

Specular on a structure

optical geometry : plane mirror = structure



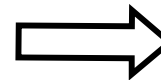
Incident Ray



Structure reflected ray



Surface reflected ray



Direct Path d_0



Two bounds multipath



Three bounds multipath

$$d_0 < d_{2_bounds} < d_{3_bounds}$$

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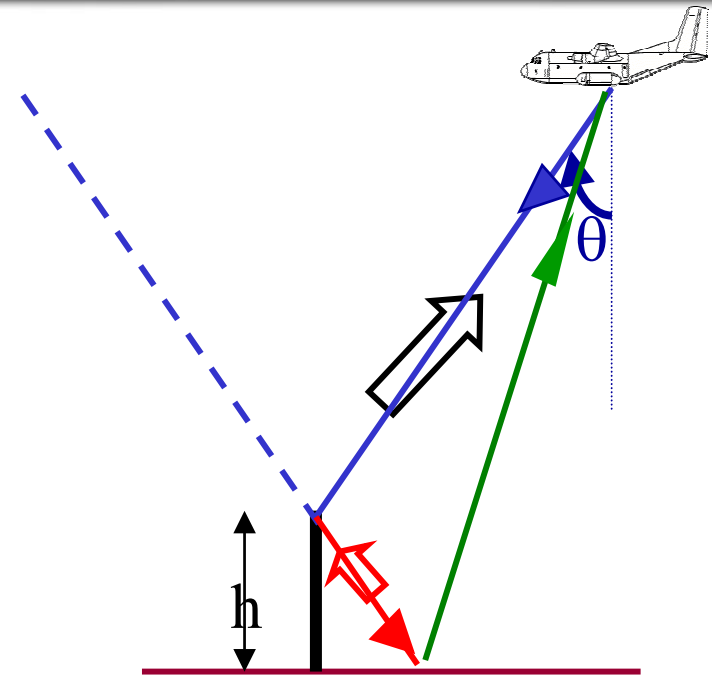
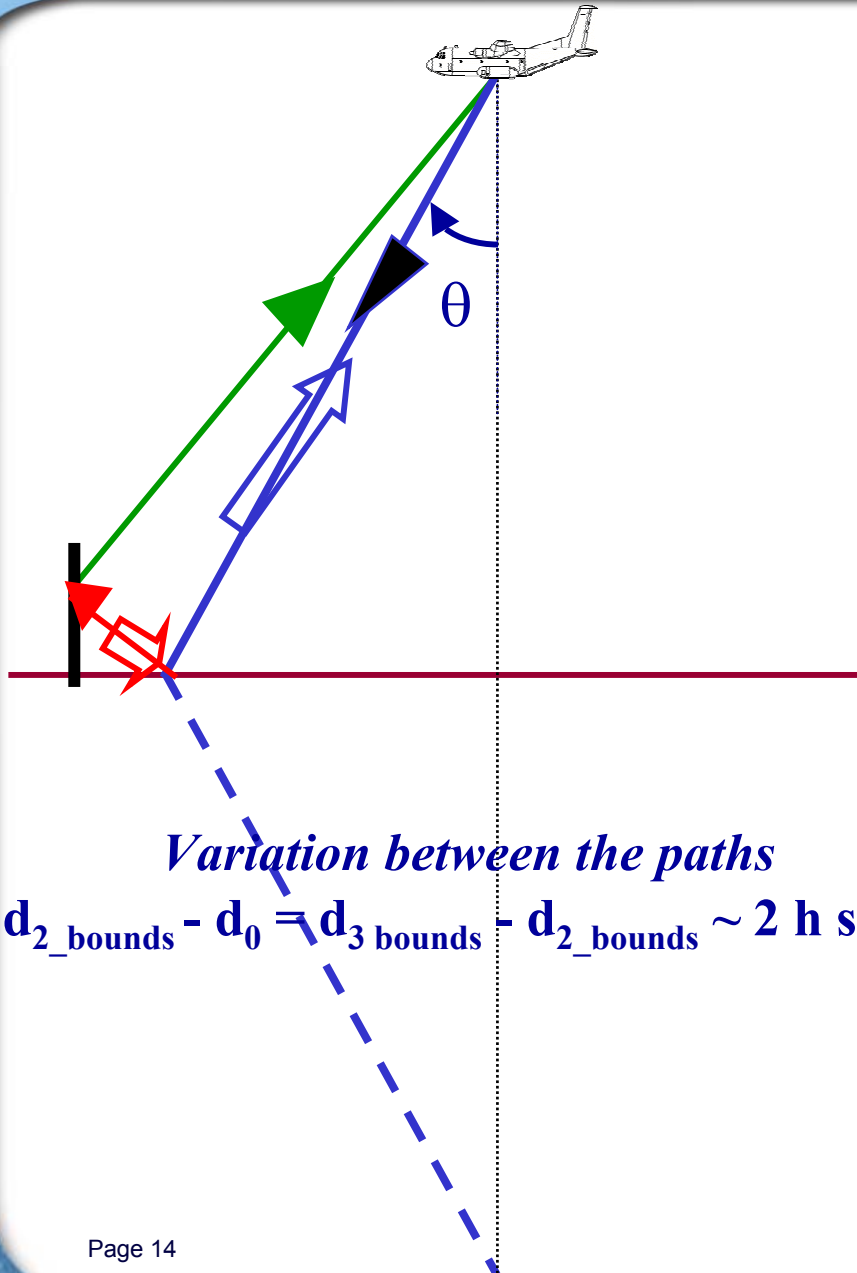
Ground specular

optical geometry : mirror plane = ground surface

Multipath

Structure specular

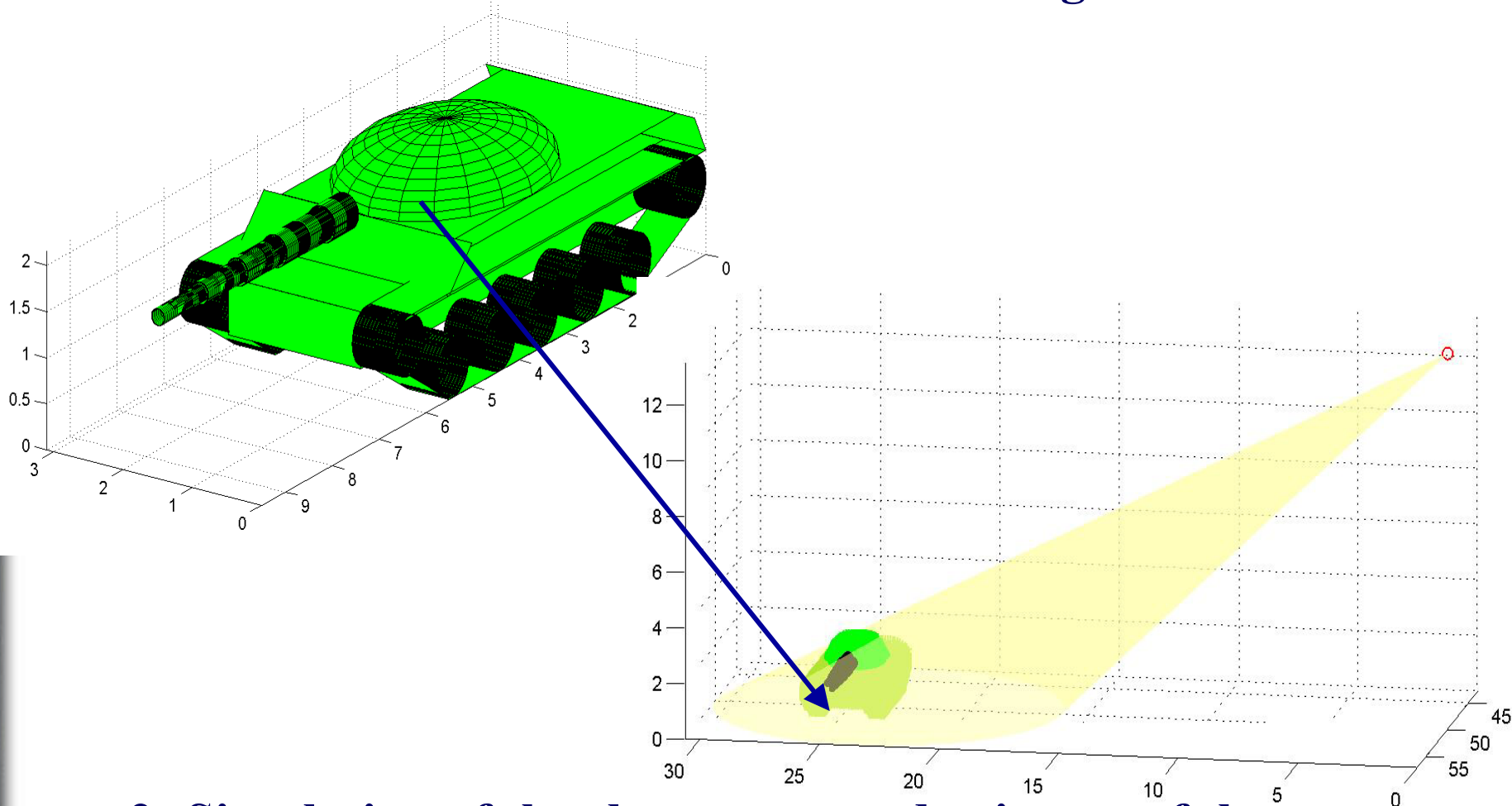
optical geometry : mirror plane = structure



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Radar image of a tank

1- Modelisation of the main features of the target

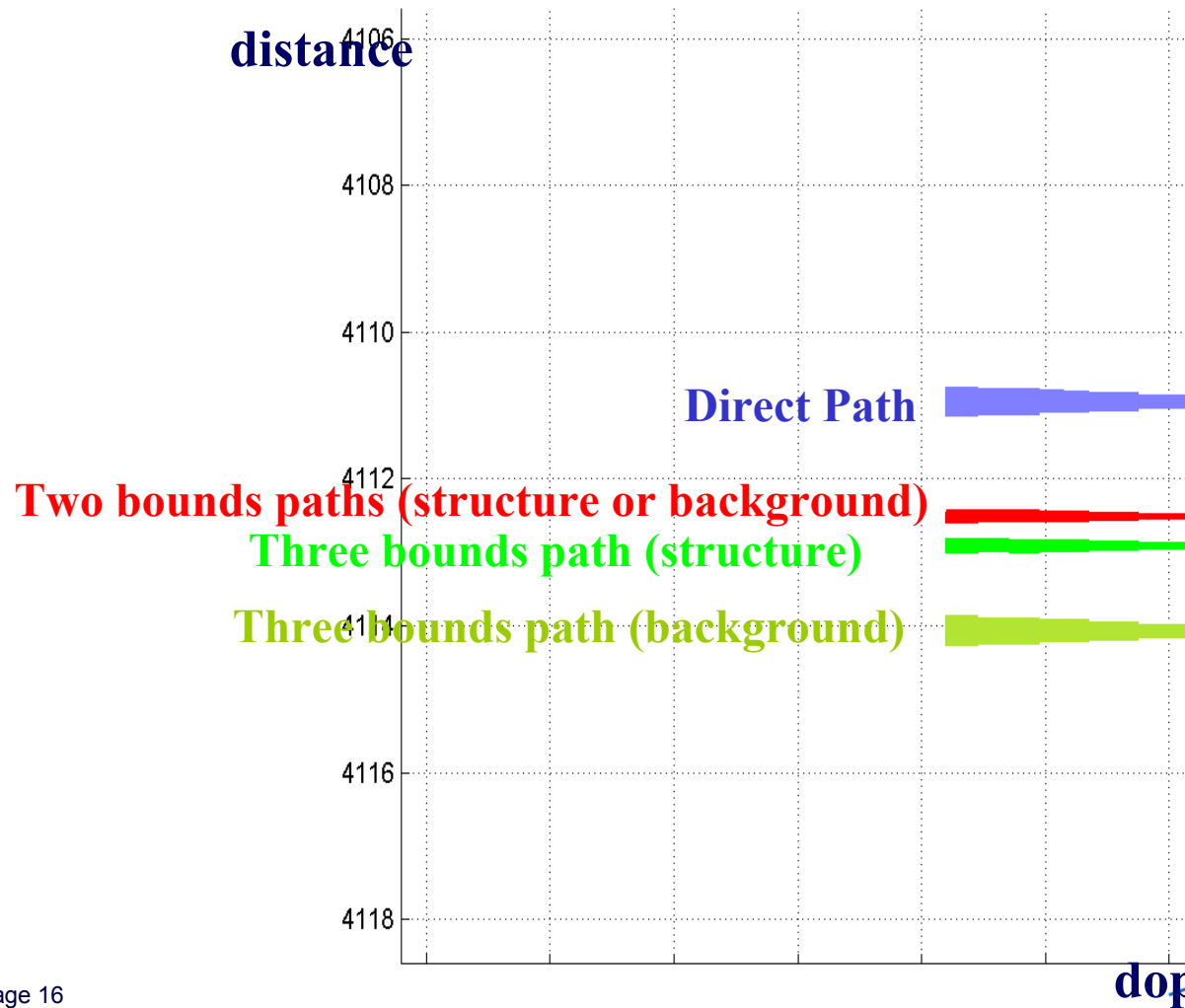


2- Simulation of the slant range radar image of the target

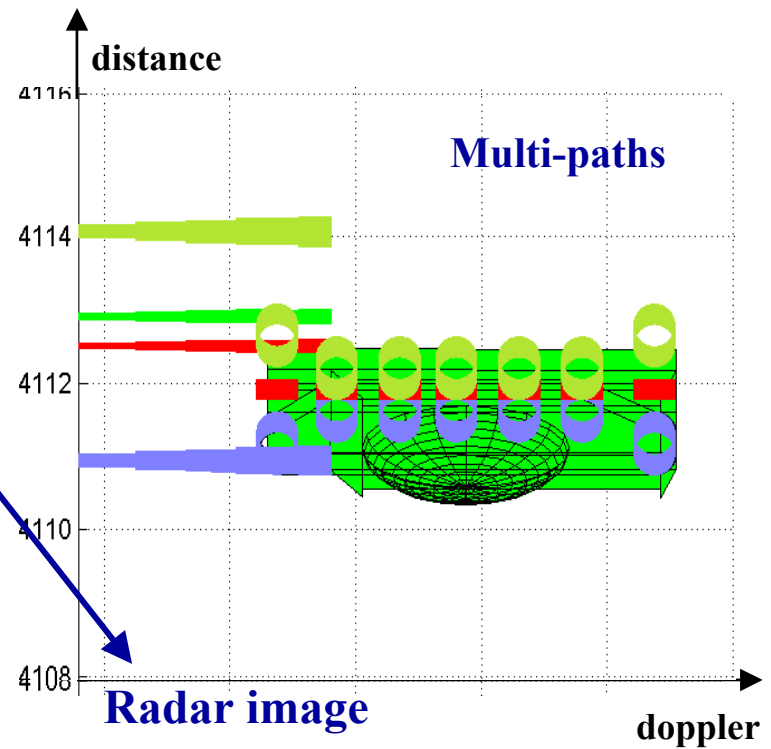
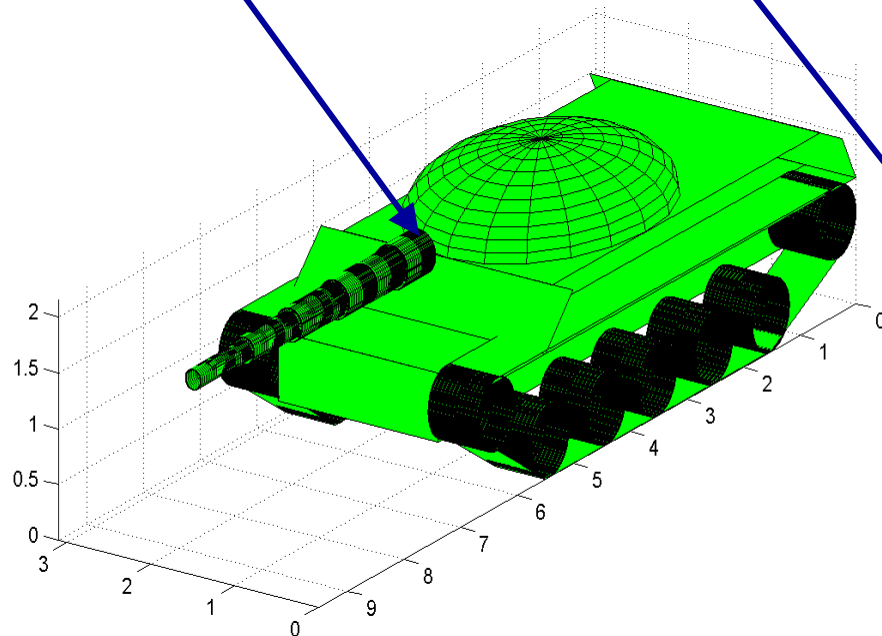
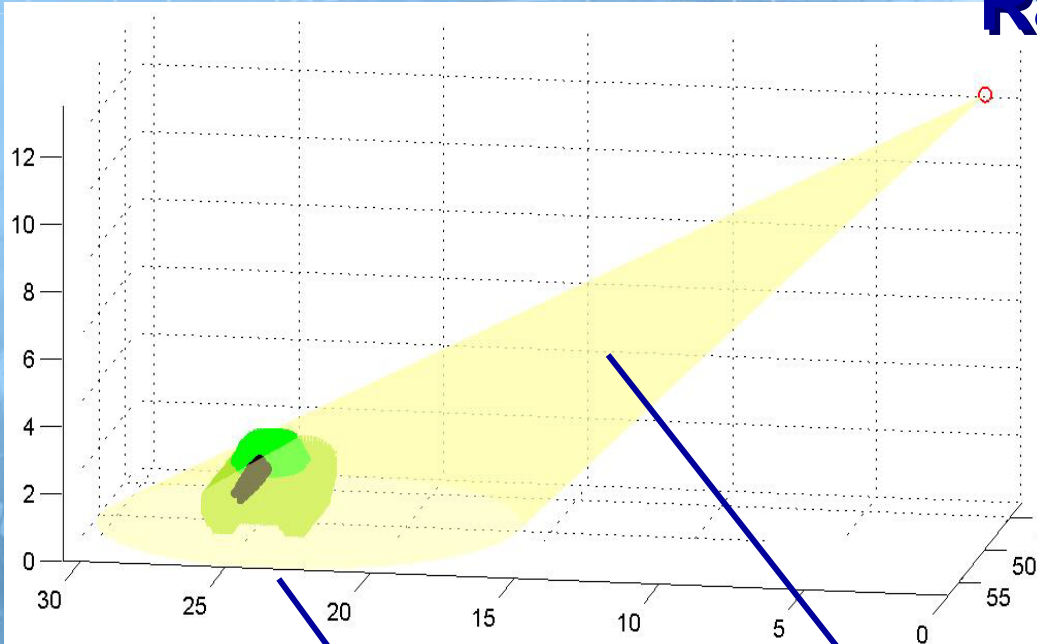
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Direct and multi paths

Example of the gun of the tank
depression angle of 60°



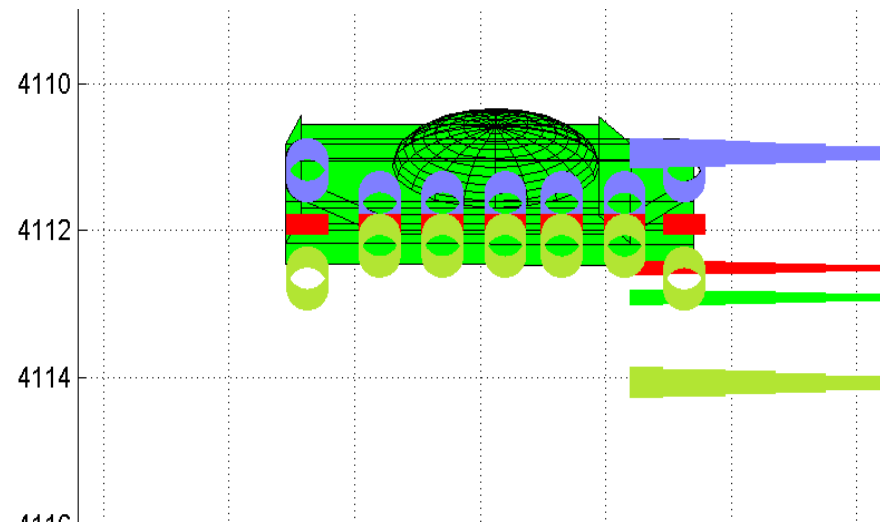
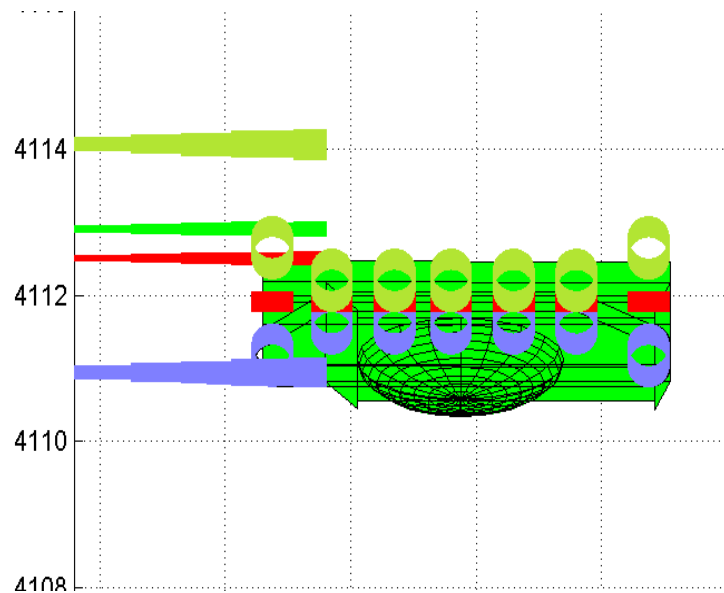
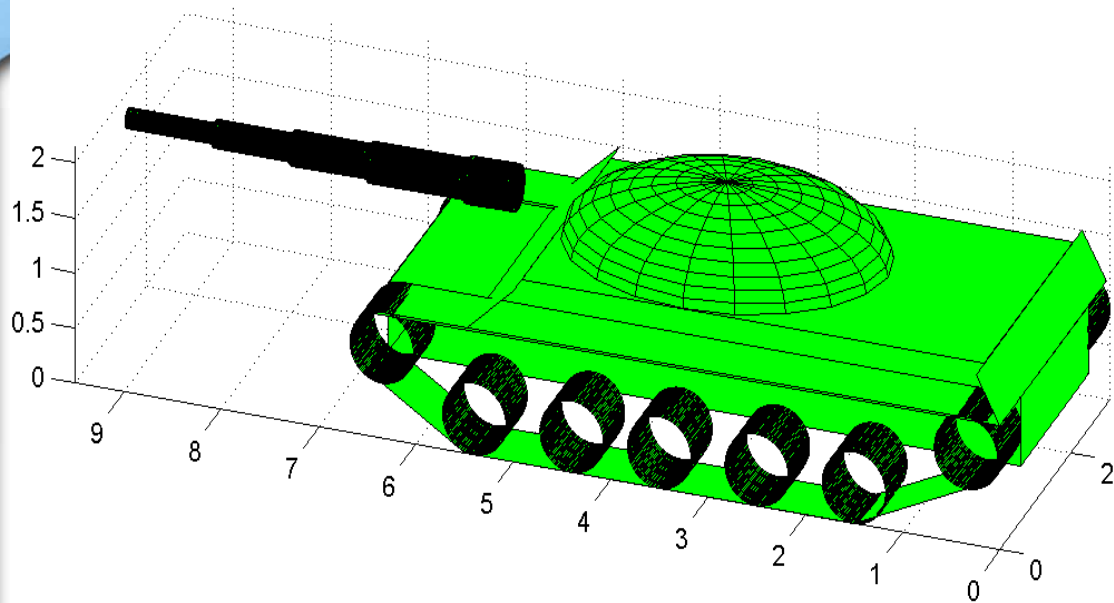
Radar image of a tank



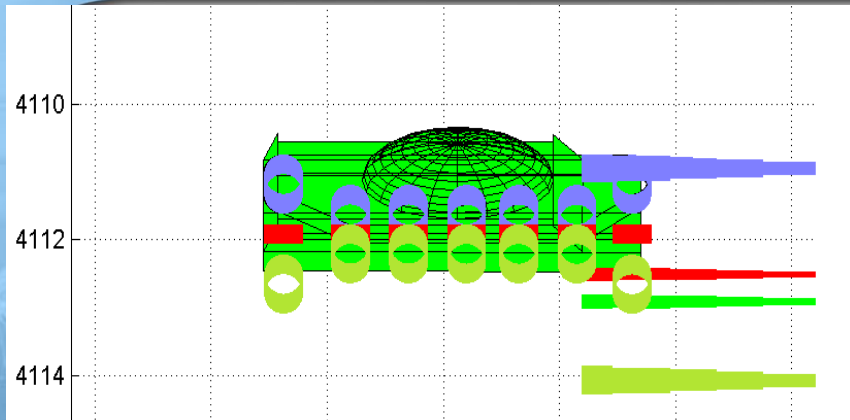
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Simulation of Radar image

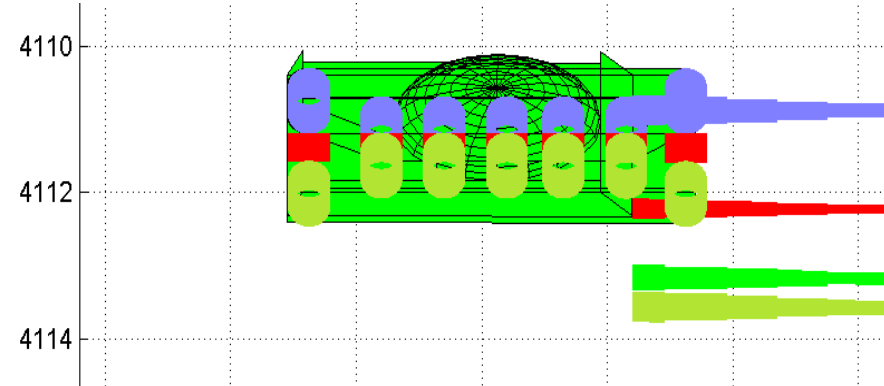
Vue 3D du char



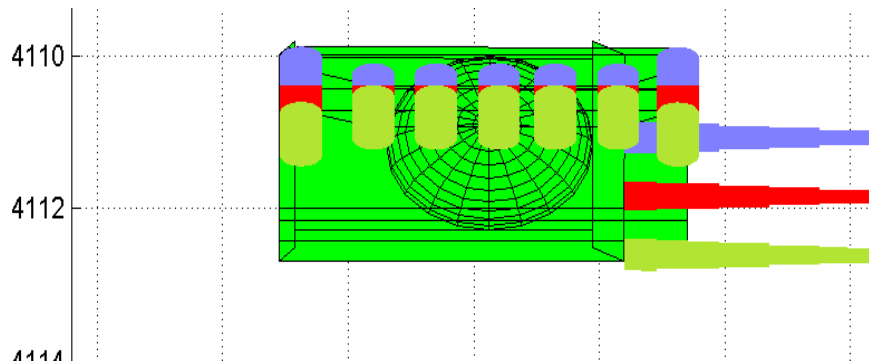
Impact of the depression angle



60°



50°



30°

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CONCLUSION

Detection - Location

➡ Yes

Recognition and Identification

➡ some interesting results with HR image

- Analyse the radar scene with the shadow, the layover,...
- Extract information from shadow
- Extract information from multi-paths

don't forget the geometry, the physics and the environment

And with Very High Resolution ...

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*This paper was received as a PowerPoint
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